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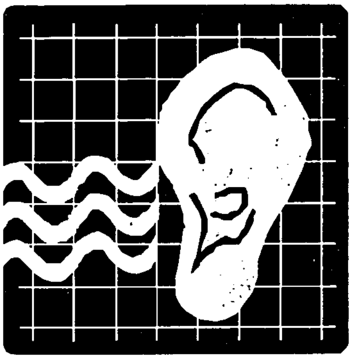
ABSTRACT

This guide is a resource for K-8 teachers, college student tutors, parents, and others engaged in learning activities to help primary, elementary, and middle school students learn mathematics and science. It presents a collection of activities adapted from printed and electronic sources which help motivate student interest in mathematics and science and make learning fun and challenging. Most items used in the activities are found in the home, particularly in the kitchen. Activities are arranged in three grade-level groups: K-2, 3-5, and 6-8. Each group includes individual activities that closely relate to grade-appropriate concepts from several science disciplines. Each activity has the following components: purpose, materials needed, what to do, questions to ask, brief explanation of mathematical or scientific concepts related to the activity, and extension activities. This publication also includes a list of Web sites and other references for finding appropriate materials for K-8 students beyond the scope of the guide. (Contains 46 Web site and print references. (SM)



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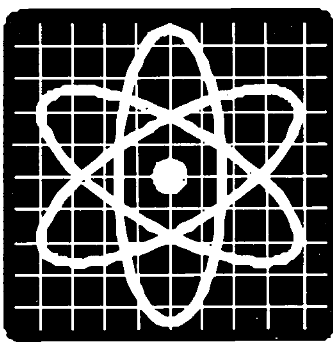
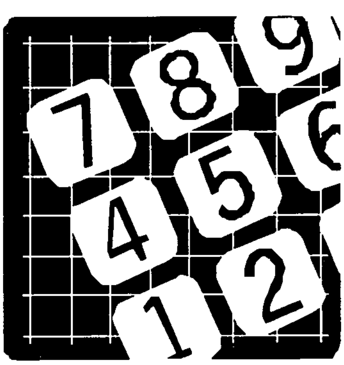


A Guide for Teachers, Tutors, and Parents



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About the QEM Network

The Quality Education for Minorities (QEM) Network was established in July 1990, as a non-profit organization in Washington, DC, dedicated to improving education for minorities throughout the nation. Operating with support from the Carnegie Corporation of New York, the QEM Network began where the MIT-based QEM Project left off. It is a focal point for the implementation of strategies to help realize the vision and goals set forth in the QEM Project's January 1990 report: Education That Works: An Action Plan for the Education of Minorities.

The QEM Network serves as a national resource and catalyst to help unite and strengthen educational restructuring efforts to the benefit of minority children, youth, and adults, while advancing minority participation and leadership in the national debate on how best to ensure access to a quality education for all citizens. It seeks to put into practice the recommendations in the QEM Action Plan by working with minority and non-minority individuals, groups, organizations, and institutions around the country.

The QEM Network employs an extensive networking and coalition building approach. One level of effort is focused on the national education scene. The other is directed towards helping local groups, organizations, and institutions develop the capacity to mobilize their communities around needed educational improvements.

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INTRODUCTION

The *Hands-on Mathematics and Science Activities* guide is designed to serve as a resource for K-8 teachers, college student tutors, parents, and others engaged in, or planning to become engaged in, learning activities to assist primary, elementary, and middle-school students. These activities may be conducted during the school day or after school. The guide is a collection of activities adapted from several sources (printed and electronic) in use across the country to motivate student interest in mathematics and science and to make learning about these subjects both fun-filled and challenging. Generally, the materials used in carrying out the activities are among items found in the home, especially in the kitchen.

To allow users of this guide to focus on students in particular grades, the activities are arranged in three grade-level groups: K-2, 3-5, and 6-8. Each of these groups includes individual activities that closely relate to grade-appropriate concepts from several science disciplines, including biology, chemistry, mathematics, and physics. This clustering allows the user to choose among activities suitable for children at various grades and that are linked to fundamental concepts in a given major field of science.

The activities presented in this guide are only a small sample of the myriad examples available on the Internet, on videodiscs, or in printed publications. In view of this, we have included a list of websites and other references so that the user can continue to find appropriate materials for K-8 students beyond the scope of this guide.

Although such activities are widely available through electronic means, many children who could benefit from the reinforcement of scientific concepts the activities offer have limited or no access to these means. Therefore, we have designed the guide to serve as a ready-made source that can be used immediately by individuals who wish to assist children in learning challenging mathematics and science. Such individuals need not be trained mathematicians or scientists but persons who have had some science and mathematics at the high school level. They must be interested in trying the activities themselves, sharing their experiences, and engaging children in the hands-on activities with which they feel comfortable.

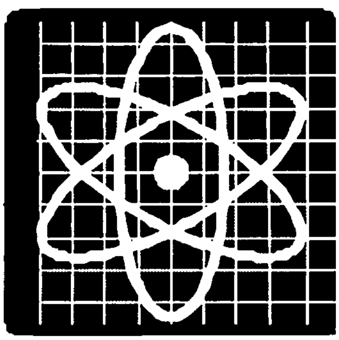
A minimal student group size and an approximate time requirement are given for each activity. Most of the activities are individualized and can be done by as few as 1-2 students or up to 15-18 students.

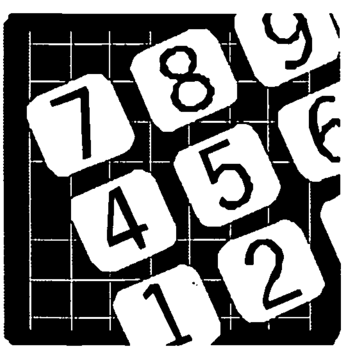
Each activity has the following components:

- Purpose (what the activity would like to have students accomplish)
- What You Need (materials needed to carry out the activity)
- What To Do (step-by-step instructions for carrying out the activity)
- Questions To Ask (suggested questions, accompanied by answers, users should ask participating students)
- Brief Explanation (a brief discussion of the mathematical or scientific concepts related to the activity)
- Extension (suggestions for extending the activity beyond its original scope to allow participating students to investigate alternative assumptions or experimental conditions)

In assisting children to learn more about science and mathematics, we anticipate that the users of this guide will find the experience to be both intellectually stimulating and personally rewarding.

TABLE OF CONTENTS





and Science Activities for Kindergarten - Grade 2

Quality Education for Minorities (QEM) Network

MOBIUS MADNESS

GROUP SIZE: 1-2
TIME: 15 minutes

PURPOSE

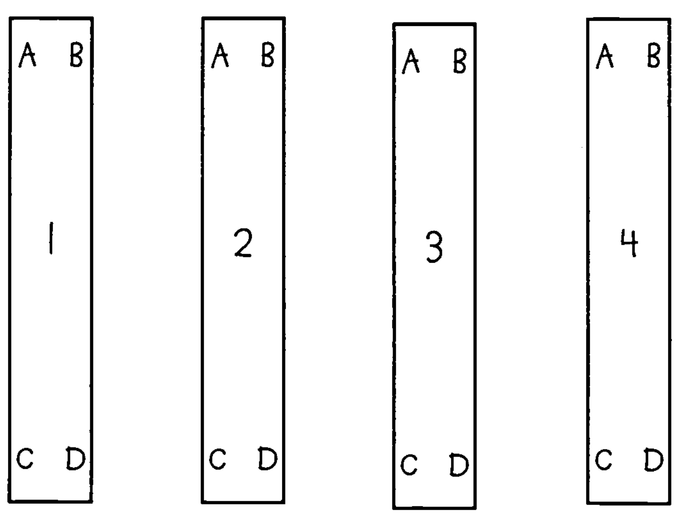
- To investigate the relationship between 2-dimensional and 3-dimensional objects.
- To compare and contrast geometric figures.

WHAT YOU NEED

- legal (8 1/2" x 14") paper
- scissors
- tape
- crayons/markers

WHAT TO DO

- Fold the paper in half lengthwise to create a 4 1/4" x 14" rectangle.
- Fold the paper in half again in the same manner to form a 2 1/8" x 14" rectangle.
- Unfold the paper and cut along the creases formed by the folds.
- On each of the four strips, starting left to right and top to bottom, label each corner A, B, C, and D.



- After labeling the corners, assign each strip a different number from 1 to 4.
- With strip 1, make a loop by overlapping corner A with the backside of corner C and corner B with the backside of corner D. Secure the ends with tape. This will be loop 1.

- Next half-twist strip 2 and then make a loop by placing corner A over corner D and corner B over corner C. Secure the ends with tape. This will be loop 2. Follow the same procedure with strip 3 to make loop 3. Save strip 4 for a spare.
- Draw a line along the center of loops 1, 2, and 3.
- Use scissors to cut along the line for loop 1, and observe what happens.
- Use scissors to cut along the line for loops 2 and 3, and observe what happens.
- Compare and contrast the new shapes formed after cutting loops 1, 2, and 3.

QUESTIONS TO ASK (Answers are in parentheses)

1) How many sides does loop 1 have?
(Loop 1 has two sides.)

2) How many sides does loop 2 have?
(Answers may vary; however, loop 2 only has one side.)

3) When a line is drawn around loop 1, what happens?
(The line is on the outer surface of the loop.)

4) When a line is drawn around loop 2, what happens?
(The line is on the outer and inner surfaces of the loop.)

5) What happens when loop 1 is cut along the line?
(Two separate loops of the same circumference but half as wide are formed.)

6) What happens when loop 2 is cut along the line?
(A new loop is formed that has the same shape, is half as wide, and longer than loop 2.)

7) What will happen to loop 3 when it is cut along the line?
(The same thing that happened to loop 2 since the procedures for forming loops 2 and 3 were identical.)

BRIEF EXPLANATION

In the 1800s, the German mathematician and astronomer August Ferdinand Mobius discovered a unique loop by twisting a rectangular strip 180 degrees and connecting the ends. This loop has one side; however, if it is cut in the middle, it becomes a long loop with two sides. This original loop is called a Mobius Strip or Mobius Band.

The Mobius Strip has been very useful in creating products such as conveyor belts and audio tapes. These products, when shaped like the Mobius Strip, wear evenly on both sides and thereby last longer.

EXTENSION

- Construct additional loops with one and two complete twists. Observe what happens.

Adapted from public domain (scidiv.bcc.ctc.edu/Math/Mobius.html)

MONEY MATCH

GROUP SIZE: 2-4
TIME: 15 minutes

PURPOSE

- To practice counting.
- To convert currency from one form to another (e.g., to convert pennies to nickles, nickels to dimes, and nickles and dimes to quarters).

WHAT YOU NEED

- one 6-sided die
- assortment of pennies, nickles, dimes, and quarters
- a bowl or plate to hold the coins

WHAT TO DO

- Review the name and value of each coin: penny, nickel, dime, and quarter.
- Explain that the object of Money Match is to be the first player to earn a set amount of money, for example, 20, 30, or 40 cents. Students earn money by taking turns rolling the die. As each student rolls, he or she earns the same number of pennies as the number on the die.
- Give the students the die and a plate or bowl of coins (the "bank"). Decide who will go first and begin play. Allow each student to draw his or her own coins from the bank after rolling the die.
- Once a student earns five pennies, he or she should trade them in at the bank for a nickel. Once two nickles are earned, exchange these for a dime, and so on.
- The first player to reach the set amount wins.

QUESTIONS TO ASK (Answers are in parentheses)

1) How many games of Money Match did you play? Who won the most games?
(Students' responses will vary.)

2) How do we tell different valued coins from each other? Can we tell by their shapes? Colors? Sizes? Something else?
(Students' responses may vary.)

3) Do you see any relationship between the size of a coin and how much the coin is worth? Which coin(s) used in this game, if any, do not fit that pattern?
(Students will probably recognize that, except for the dime, the larger a coin is, the larger its worth.)

4) Do you think there is a relationship between the size of different dollar bills and their worth?
(Dollar bills in the United States do not vary in size, but it may be interesting to show students samples of currency from countries whose paper money does vary in size and/or color such as Ireland and India.)

BRIEF EXPLANATION

This activity helps students learn the names and values of various coins while practicing two basic mathematical skills: addition and conversion. However, with creative questioning, students also may begin to identify characteristics of the coins, notice relationships and patterns between the coins' characteristics, and classify the coins according to their characteristics.

EXTENSION

- Have students imagine they are founding members of the United States and must create a new currency. Tell them to create new coins (with original names) for their new country and ask them to explain how their conversion system works.

Adapted with permission from *U.S. Department of Education*, 2000.

EXTRA SENSES

GROUP SIZE: 1-2
TIME: 15 minutes

PURPOSE

- To examine the sense of sight and the sense of hearing.
- To create simple tools to enhance the senses of sight and hearing.

WHAT YOU NEED

- index card
- safety pin
- large sheet of paper
- tape

WHAT TO DO

To Make a Magnifying Glass

- Make a hole in the center of an index card with a safety pin.
- Cover one eye and lean approximately 4-5 inches above a piece of paper on which a sentence has been typed in very small print (I love science and mathematics!).
- Place the index card with the hole in front of the uncovered eye. Focus the uncovered eye to look through the hole. Read the sentence.
- Switch eyes and re-read the sentence.
- Open both eyes and read the sentence without using the index card.

To Make a Hearing Aid

- Roll a large sheet of paper into a cone. Make one end of the cone the size of a dime and the other end as wide as possible.
- Tape the sides of the cone in place to keep the cone from unraveling.
- Hold the narrow end of the cone to the ear.
- Carefully listen and observe different sounds through the cone.

QUESTIONS TO ASK

(Answers are in parentheses)

1) Could you read the sentence in small print using the index card?
(Responses will vary.)

2) Could you read the sentence in small print after the card was placed in front of your eye?
(Yes.)

3) Did the size or shape of the sentence change when you used the card?
(Yes, the picture appears larger and sharper.)

4) What did you hear when you placed the cone to your ear?
(Answers will vary.)

5) Did the cone make sounds and noises louder?
(Yes, the sounds were louder.)

BRIEF EXPLANATION

Explanation for the Magnifying Glass

All objects give off a type of energy called radiant energy, or light. During sight, the eye receives the energy and uses that energy to "see" an object. If the object is too small, too close, or too far away, then the object appears blurry.

Special tools such as magnifiers, or pinholes, can help with sight because they "trick" the eyes. They trick the eyes by narrowing the focus on the object and bending the light before it reaches the eye, thus, limiting the amount of light that enters the eye. As a result, it makes the object appear larger.

Explanation for the Hearing Aid

The outer structure of the ear plays an important role in allowing sounds to be heard. The ear is shaped similar to a cone; it begins as a small opening and ends as a wide piece of cartilage on the side of the head. Cone-shaped objects allow large amounts of air, for example, to be collected and passed through a very small opening. The ear collects sounds, which are vibrations of moving air, and funnels the vibrations to the cochlea (spiral cavity of the inner ear) which then sends signals along the nerves to the brain.

Typically, the larger the cone, the more air vibrations that can be collected and funneled. Consider animals in the wild that depend on good hearing for hunting or spotting enemies. Many of them have larger ears. By creating the cone-shaped "hearing aid" that is larger than the human ear, more sounds can be collected and heard.

EXTENSION

- Change the size of the hole and examine how the size affects what is seen.
- Change the size of the cone and examine how the new size affects hearing.

Adapted with permission from *Science Exploratorium*, 2000.

COPPER CAPER

GROUP SIZE: 1-4
TIME: 30 minutes

PURPOSE

- To introduce the concept of chemical reactions.
- To develop observation skills by examining changes in the appearance of a penny placed in an acid (vinegar-salt) solution.

WHAT YOU NEED

- 2 "dirty" pennies
- vinegar
- salt
- water
- paper towels
- cup
- marker

WHAT TO DO

- Put 1/4 cup of vinegar and 1 teaspoon of salt in the cup.
- Carefully put the two pennies in the cup.
- Gently swirl the cup for a few seconds.
- Put the cup on a table and allow it to remain undisturbed for 15 minutes. Periodically, observe what happens to the pennies.
- Tear off two sheets of paper towel and use a marker to label one sheet "Rinsed" and the other "Unrinsed."
- After the 15 minutes, remove one penny from the cup and put it on the "Unrinsed" towel.
- Remove the remaining penny from the cup. Immediately rinse the penny in a cup of water, dry it with a clean paper towel, and put it on the "Rinsed" towel.
- Let both of the pennies dry.
- Observe what happens to the pennies as they dry.

QUESTIONS TO ASK

(Answers are in parentheses)

1) What happened to the pennies when they were put into the cup with the vinegar and salt? (The pennies began to shine.)
2) What happened to the pennies that were rinsed? What happened to the pennies that were not rinsed?
(The pennies on the "Rinsed" towel remained shiny but the pennies on the "Unrinsed" towel turned green.)
3) Why do you think the "Rinsed" pennies look different from the "Unrinsed" pennies? (Answers will vary.)

BRIEF EXPLANATION

Chemical reactions are everywhere and they are constantly occurring because everything is made of chemicals. During a chemical reaction, two or more chemicals combine to form new chemicals.

In this activity, three different chemical reactions took place. The first reaction was the tarnishing of the penny. (The first reaction actually occurred prior to the activity; however, the end result can be noted in this activity.) When pennies are new, they are bright and shiny. As pennies age, they lose their shiny, bright color and become dull and dark. This dulling process is referred to as tarnishing. All pennies contain a chemical element called copper. Tarnishing occurs when the copper is exposed to air for long periods of time. When copper is exposed to air, it combines with another chemical element called oxygen to form a chemical called copper oxide or tarnish.

The second reaction to occur in this activity is the removal of tarnish. Tarnish can be removed with an acid which is a chemical. Acids can be found in foods such as lemons, oranges, and vinegar. They can also be found in many commonly used products including sodas, batteries, polishes, and fertilizers. They also are found in the human body. For instance, the human stomach contains acid that is used in digesting food.

The third and final reaction to occur was the formation of the green substance on the "Unrinsed" penny. The "Unrinsed" penny turned green because the vinegar and salt were not removed as they were from the "Rinsed" penny. Vinegar and salt are chemicals. These chemicals also react with oxygen to form a green colored chemical called malachite.

EXTENSION

- Repeat the experiment substituting the vinegar with another acid such as lemon juice. Does the acid remove the tarnish faster than vinegar? Does a new chemical form on the surface of the penny if the acid is not removed?
- Add non-coated steel nails, screws, and/or paper clips to the vinegar and salt after the pennies have been in the cup. Observe what happens. What conclusions can you reach?

Adapted with permission from *Science Exploratorium*, 2000.

IT'S IN THE BAG

GROUP SIZE: 1-2
TIME: 30 minutes

PURPOSE

- To observe the changing forms of matter.
- To study how the process of heat transfer is used in the preparation of ice cream.

WHAT YOU NEED

- 1 cup milk
- 4 tbsp sugar
- 1/4 tsp vanilla
- rock salt
- ice
- 1-gallon size storage baggie
- sandwich size baggies
- newspapers
- duct tape

WHAT TO DO

- In the small baggie, combine the milk, vanilla, and sugar.
- Seal the baggie. Make sure to remove the excess air.
- Fill 1/3 of the large baggie with ice. Add enough salt to cover the top surface of the ice.
- Place the small baggie inside the large baggie.
- Add more ice and salt around the small baggie.
- Seal the large baggie. Make sure to remove the excess air.
- Wrap the baggies in newspaper to form a bundle.
- Seal the newspaper with duct tape.
- Toss and shake the bundle vigorously for 5-10 minutes.
- Open the bundle and see if the ingredients have solidified into ice cream. If not, rewrap the bundle and shake again.
- Eat and enjoy.

QUESTIONS TO ASK (Answers are in parentheses)

1) How does shaking and tossing the baggies help make ice cream?
(The shaking and tossing of the baggies allow all of the ingredients to mix evenly.)

2) What is the purpose of adding salt to the ice? Could the ice cream be made without using salt?
(The salt causes the ice to melt at a faster rate. The ice cream can be made without the salt but it would take more time (possibly, hours).)

3) What is the purpose of wrapping the baggies and ingredients in newspaper?
(The newspaper insulates the baggies. The insulation prevents the baggies from receiving or releasing heat into the environment.)

4) Did the ice cream freeze within 10 minutes? Why or why not?
(Answers will vary. Possible reasons for the ice cream not freezing are not enough shaking, too little salt, too little ice, or too little newspaper.)

BRIEF EXPLANATION

Cooking and preparation of foods provide a wonderful opportunity to study basic concepts in science while at the same time enjoying good food. The preparation of ice cream, for example, demonstrates two principles of chemistry: the changing forms of matter and heat transfer.

Matter is a term used to describe anything that takes up space and has mass (weight). Matter has three forms: gas, liquid, and solid. It can change between these forms through the processes of boiling, melting, and freezing. For instance, the ingredients for ice cream are liquid and they freeze into a solid, while the ice and salt begin as solids and melt into a liquid.

When matter changes forms, heat is either released or absorbed. The laws of nature require that matter can only give or absorb heat from other matter. The movement of heat between different matter is called heat transfer. In the preparation of ice cream, heat is being transferred between the small baggie containing the ice cream ingredients to the big baggie containing the ice and salt. As the ingredients freeze into the ice cream, heat is given to and taken by the salt and ice to melt.

EXTENSION

- Add your favorite toppings/additional ingredients to the mixture. Do the toppings/ingredients change how long it takes for the ice cream to form?

- Take and record the temperature of the ice before the salt is added and then after the formation of the ice cream. Take and record the temperature of the milk before and after the formation of the ice cream. Graph the recorded temperatures. Is the change in temperature the same between both baggies?

- Change one of the following and observe what happens:
    1) the amount of newspaper used as insulator
    2) the amount of salt
    3) the fat content of the milk.

Adapted from public domain (celster@gilligan.esu7.k12.us).

LAVA LAMP

GROUP SIZE: 1 - 2
TIME: 30 minutes

PURPOSE

- To examine density as a property of water, oil, and salt.
- To study how immiscible (non-mixing) fluids interact with each other.

WHAT YOU NEED

- 20 oz. clear plastic bottle with lid
- water
- food coloring
- vegetable oil
- salt

WHAT TO DO

- Fill the 20 oz. plastic bottle with approximately 4-5 inches of water.
- Add 1-2 drops of food coloring.
- Add 1/4 cup of vegetable oil to the bottle. Wait until two layers form.
- Shake the salt into the jar while slowly counting to five. Watch what happens.
- After counting to five, stop adding the salt but continue observing the bottle.
- Repeat the last two steps and continue to watch what happens.

QUESTIONS TO ASK — (Answers are in parentheses)

1) Do the oil and the water mix? Why or why not?
(The oil and the water do not mix because they are immiscible fluids, fluids that cannot be mixed because of their chemical make-up.)

2) Why does the oil float to the top when it is added to the water?
(The oil floats because it is less dense than the water. The oil molecules are less tightly packed than the water molecules are.)

3) What happened when the salt was added to the oil and water?
(The salt and the oil formed a glob that sank to the bottom of the bottle.)

4) Describe what happened after the salt was no longer added?
(After the salt and oil globs sank to the bottom of the bottle, the globs began to float back up to the top.)

5) What happened to the salt that sinks to the bottom of the bottle?
(The salt dissolves in the water.)

BRIEF EXPLANATION

Oil and water do not mix. No matter how hard or vigorously they are blended, shaked, stirred, or mixed, they will never become one. Therefore, oil and water are called immiscible liquids. Immiscible liquids have certain properties that cause the liquids to quickly separate themselves from each other to form different, distinct layers.

One property that immiscible liquids use to separate themselves is density. Density is the ratio of mass (weight) to volume. It determines the "heaviness" of one thing to another within a given space or area. Oil has a lower density than water, which is why it floats on top of water. Salt has a higher density than both oil and water, so it sinks in both oil and water.

EXTENSION

- Next use a 2-liter soda bottle. Use scissors to cut the top two inches from the bottle. Add water and oil to form two distinct layers of fluids, then add kerosene to create yet a third layer. Drop a penny, a small candle, and a cork into the bottle. Ask students what they can deduce about the density of these objects'/fluids' molecules based on what they see in the bottle.

Adapted with permission from *Science Exploratorium*, 2000.

ROTO-COPTER

GROUP SIZE: 1 - 2
TIME: 30 minutes

PURPOSE

- To model a helicopter rotor and examine how a helicopter works.

WHAT YOU NEED

- Roto-copter patterns (See examples on page 18.)
- scissors
- markers or crayons
- pencil
- large sheet of paper or newspaper

WHAT TO DO

- Color and decorate each of the Roto-copter patterns.
- Cut out the patterns along the solid lines.
- Fold each pattern along the dotted lines in the following manner: fold A towards you 90 degrees, B away from you 90 degrees, C and D towards each other so that they overlap, and the bottom upwards.
- Attach a paper clip to the bottom fold.
- Drop or throw each of the Roto-copters. Observe what happens.
- On one of the Roto-copters, change the directions of the folds for A and B. Fold A away from you and B towards you. Again, drop or throw the Roto-copter and observe what happens.

- To play a Roto-copter game, first make a target. Open a newspaper sheet on the floor so that it forms a large rectangle. Use tape to keep the paper in place.
- In the center of the sheet, draw a circle about 20 inches in diameter. Inside this circle, draw a smaller circle about 14 inches in diameter. Fill in the smaller circle with a marker; this will be the bull's eye.
- To play the game, divide students into teams.
- Players should line up 1-3 feet away from the target. Taking turns, each player should throw his or her Roto-copter at the target.
- After all players have thrown their Roto-copters, each team should tally the points according to where each of the Roto-copters landed. Students receive 3 points for a bull's eye, 2 points for the circle surrounding the bull's eye, and 1 point for landing somewhere on the paper outside of both circles. No points are awarded if the copter does not land somewhere on the paper.

QUESTIONS TO ASK (Answers are in parentheses)

1) What happened to the Roto-copter as it fell to the ground?
(The Roto-copter spun in circles like the rotor of a helicopter.)

2) What differences, if any, do you notice between how the small and large Roto-copters fly?
(The small Roto-copter spins more quickly than the larger one does.)

3) When you changed the direction of the folds for parts A and B, what effect did this have on the Roto-copter, if any?
(When you change the direction of the folds, the Roto-copter will spin in the opposite direction as it falls. That is, it will spin counterclockwise instead of clockwise.)

BRIEF EXPLANATION

A Roto-copter is a model of the rotor on a helicopter. A rotor is the wing-like blade on top of a helicopter that allows the helicopter to take off vertically without the need of a runway. The rotor has a design similar to an airplane's propeller, but serves a greater function. The propeller on an airplane only gives the plane thrust (forward movement), and the plane's wings give it lift (vertical movement). The helicopter's rotor provides both thrust and lift.

Basically, here is how a rotor works: When the rotor is directly parallel to the ground, the helicopter can move directly up or down, or sit still. When the rotor is tilted slightly forward, backward, left, or right, the helicopter moves in those directions. Changing the speed of the spinning rotor allows the helicopter to change altitude. The propeller on the tail changes the direction in which the nose of the helicopter points.

The smaller Roto-copter spins more quickly than the larger one because its shorter wings encounter less air resistance than do the longer wings. The direction in which the Roto-copter spins depends upon how the wings are fixed around its central (vertical) axis. The outside edge of each wing of the rotor (i.e., the edge farthest from the central axis) spins against the air.

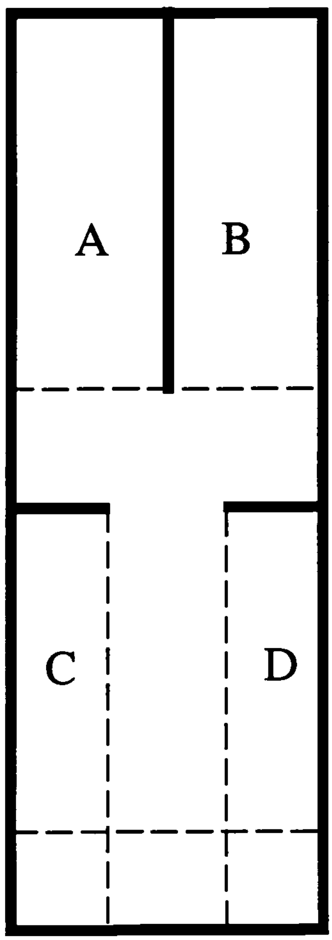
EXTENSION

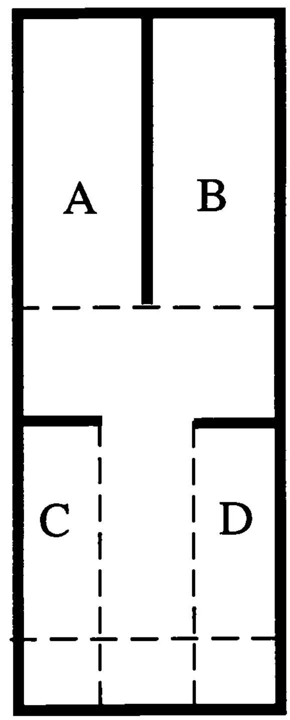
- Try using other materials to create a better Roto-copter. Build even larger or smaller sizes to test which ones fly best.

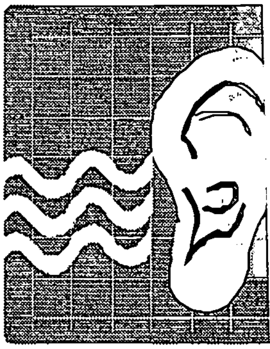
Adapted with permission from *Science Exploratorium*, 2000.

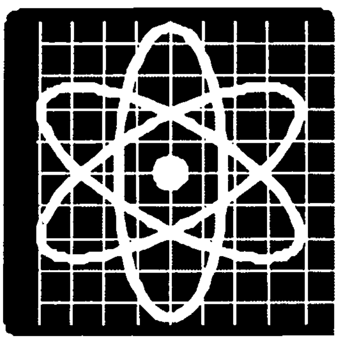
Roto-copter Patterns

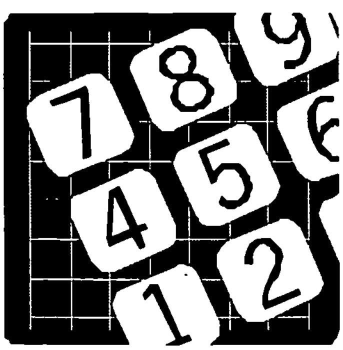
- Color and decorate each of the Roto-copter patterns.
- Cut out the patterns along the solid lines.
- Fold each pattern along the dotted lines in the following manner: fold A towards you 90 degrees, B away from you 90 degrees, C and D towards each other so that they overlap, and fold the bottom upwards.
- Attach a paper clip to the bottom fold.











and

Science Activities

for

Grades 3 - 5

Quality Education for Minorities (QEM) Network

HIDING HURKLE

GROUP SIZE: 2-4
TIME: 20 minutes

PURPOSE

- To practice naming points on a coordinate grid and using compass directions.

WHAT YOU NEED

- pencil or pen
- graph paper

WHAT TO DO

- Explain or review the directions on a compass: North, South, East, West, Northeast, Southeast, and so on.

- Explain or review how to name coordinates on an X-Y coordinate system (coordinate plane).

- Using graph paper, create two identical X-Y coordinate systems on which to play the game. For students who have just begun graphing coordinates, it may be best to begin with a simplified plane that has only positive numbers. As students' skills improve, use a larger or complete coordinate system to make the game more challenging.

- Explain that a "Hurkle" is a fuzzy, imaginary creature that loves to hide and can hide almost anywhere — even behind a small point on a coordinate system. In this game, a leader will hide the Hurkle somewhere on the X-Y system, and the remaining players must try to find it.

- To begin, choose a leader who will hide the Hurkle for the first game. (In subsequent games, each player should have an opportunity to be the leader.) Give the leader one copy of the two identical X-Y systems and the other copy to the remaining students. Have the leader secretively choose any point on the X-Y coordinate system. This point is where the Hurkle is hiding for this game. Without showing the other players, the leader draws an "X" on his or her grid to mark where this Hurkle is hiding. Then announce to the players, "A Hurkle is hiding! Can you find it?"

- The other students now take turns guessing where the Hurkle is. They should do this by naming a set of coordinates, not by pointing to a spot on the graph. As students make their guesses, they will mark these points on their graph paper.

- Following each guess, the leader draws a small dot on his or her grid marking the point that was guessed. The leader then responds to the students, telling them whether they have or have not found the Hurkle. If the students did not find the Hurkle, the leader must give them a clue. As a clue, the leader tells the players what direction they should travel from their last guess to find the Hurkle.

- The students should keep track of their guesses and clues, narrowing down the space on the coordinate system until they find the Hurkle. Talk with students about the best strategies for finding the Hurkle with the fewest guesses possible.

QUESTIONS TO ASK (Answers are in parentheses)

1) Who was best at finding the Hurkle? Who was best at hiding it?
(Students' responses will vary.)

2) When you were looking for the Hurkle, how did you decide where to make your guesses? Did anyone come up with a strategy for making good guesses?
(Initially, students' guesses will probably be random. After a few games, however, students may begin to use the directional clues to "scratch out" portions of the grid where they know the Hurkle cannot be hiding. In this way, additional guesses and clues help them narrow the search area.)

BRIEF EXPLANATION

Simply, this game is designed to make work fun. The skills students use in this game are fundamentally important in algebra, geometry, physics, and advanced mathematics classes. Furthermore, approximating area and distance, translating clues into useful information, and making good guesses (hypothesizing) are also important skills for students who might enjoy careers as scientists, engineers, navigators on boats or airplanes, or topographers (map makers).

EXTENSION

- Play the game on all four quadrants of a complete X-Y coordinate system.

Adapted with permission from *Family Math*, Lawrence Hall of Science, 1986.

"SUM" TIC-TAC-TOE

GROUP SIZE: 2
TIME: 10 minutes

PURPOSE

- To practice basic addition and mental arithmetic.
- To develop strategy and problem solving skills.

WHAT YOU NEED

- paper
- pencil or pen

WHAT TO DO

- To begin, draw an ordinary tic-tac-toe grid. Decide who will go first.

- As in ordinary tic-tac-toe, two students will alternate turns. Rather than playing with "X's" and "O's" however, students will take turns adding a number, 1 through 9, to a space on the tic-tac-toe board. The object of the game is to be the first student to make three numbers in a row -- vertically, horizontally, or diagonally -- add up to exactly 15.

- Play begins when the first student chooses a number from 1-9 and writes that number in one of the nine spaces on the board. Once a number has been used in a game, it cannot be used again by either player. For example, if the first student puts an 8 in the center of the board, then the next student can only choose from 1-7, or 9.

- Next, the other student chooses from the remaining numbers and adds one number to the board. The student should choose carefully, however. Either student can use any of the numbers on the board to make 15; students are not limited to using the numbers they have written themselves. Thus, the student who takes the second turn should be careful not to set up his or her opponent for an easy win.

- Students alternate turns until someone plays a number that makes three squares in a row total 15, or until all the spaces are filled and the game ends in a tie.

- Remind students that each number from 1-9 can only be played once, and that it takes three numbers in a row to make a winning sum of 15.

QUESTIONS TO ASK (Answers are in parentheses)

1) How many times did you play with your partner? Who won the most games?
(Students' responses will vary.)

2) Did you find that certain numbers or spaces were better to use than others? Why?
(Students' answers may vary. However, only one strategy provides a consistent advantage to a player. See the explanation below.)

3) Can you explain how a good *defensive* strategy can help you to win a game?
(As in traditional tic-tac-toe, after a few games students will realize that to win they must play defense well. If a player cannot win during a turn, then the player must choose a number and a space on the board that will not give the opponent a chance to win.)

BRIEF EXPLANATION

Winning strategies depend upon number selection and placement. Unlike traditional tic-tac-toe, in this activity each player may use all spaces on the board to win, not just his or her own spaces. After several games students may discover a strategy that allows the first player to win everytime: placing a 5 in the center square on his or her first turn. In the 1-9 number set, there are four numbers on either side of the 5, each with a match that adds to 10. For example, 1 matches with 9, 2 with 8, and so on. So, no matter what number or where the opponent chooses to play next, the first player can then play that number's match and win the game.

EXTENSION

- Develop a variation on this game that uses a larger board, restricts players to using only even numbers, or contains a number set that includes both positive and negative numbers.

Adapted with permission from *Family Math*, Lawrence Hall of Science, 1986.

TANGRAMS

GROUP SIZE: 1-2
TIME: 30 minutes

PURPOSE

- To move and manipulate three types of geometric shapes (triangles, squares, and parallelograms) of different sizes.
- To recognize spatial and geometric patterns.
- To develop an understanding of spatial relationships.

WHAT YOU NEED

- worksheets: "Tangram Template," "Tangram Puzzles," and "Tangram Puzzles Solutions"
- scissors
- posterboard
- crayons/markers
- glue/paste

WHAT TO DO

- On a blank sheet of paper, trace the pattern from the "Tangram Template."
- Decorate the pattern using crayons/markers.
- Cut out the pattern by first cutting along the square boundary lines. Then, cut along the solid lines within the pattern in order to get 7 shapes: 1 square, 1 parallelogram, 2 small triangles, 1 medium triangle, and 2 large triangles.
- Paste or glue the shapes separately on a posterboard and cut out the shapes.
- Using the shapes, solve as many tangram puzzles as possible from the "Tangram Puzzles" worksheet. Remember to use all 7 pieces for each puzzle. The pieces must not overlap.

QUESTIONS TO ASK

(Answers are in parentheses)

1. Which puzzles were easiest to solve? Why?
   (Responses will vary.)
2. Which puzzles were most difficult to solve? Why?
   (Responses will vary.)

BRIEF EXPLANATION

The tangram is an ancient Chinese puzzle used for entertainment throughout the centuries. Each puzzle consists of one large shape or figure formed by seven smaller shapes: a square, a parallelogram, and five triangles (one medium, two small, and two large). The puzzle is solved when all seven shapes have been arranged, without overlapping, to resemble the identified figure (barn, candle, chair, etc.).

Solving tangram puzzles requires the use of important problem-solving skills, including the ability to recognize the relationships among geometric shapes. These skills will not only be important in the study of other mathematics such as geometry but also in everyday activities such as packing.

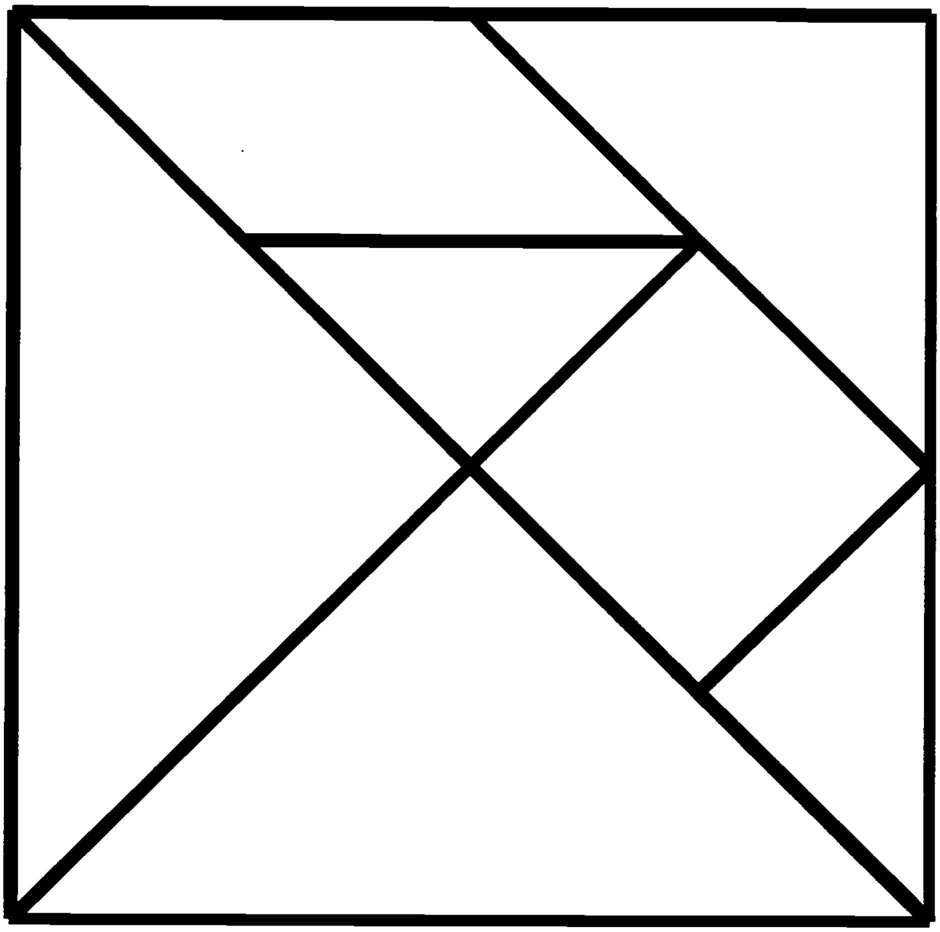
EXTENSION

- Have each student design an original puzzle using the seven tangram pieces.

Adapted with permission from *Family Math*, Lawrence Hall of Science, 1986.

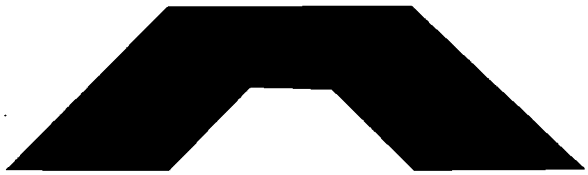
Tangram Template Worksheet

Decorate and cut out the following pieces. You should end up with 7 shapes total: 5 triangles, 1 square, and 1 parallelogram.



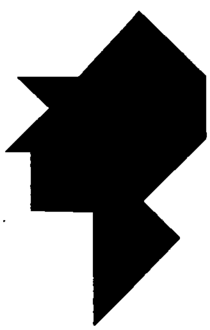
Tangram Puzzle Worksheet


BARN


BRIDGE

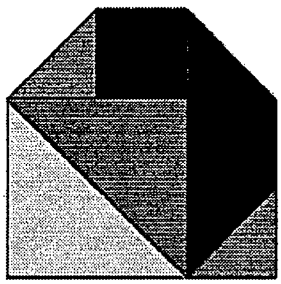

CANDLE


CHAIR

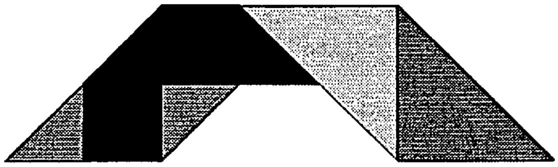

MAN


MOUNTAIN

Tangram Puzzle Solutions Worksheet



BARN



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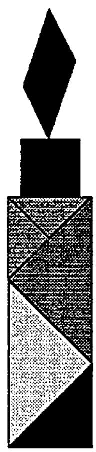
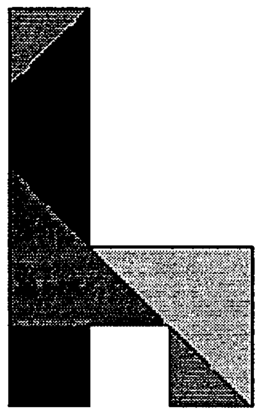
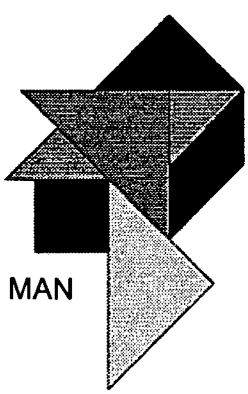


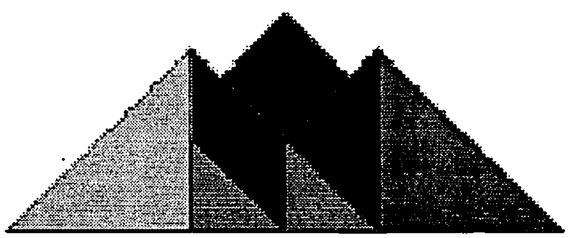
CANDLE



CHAIR



MAN



MOUNTAIN

BACTERIA HUNTERS

GROUP SIZE: 4
TIME: 75 minutes

PURPOSE

- To collect and study bacterial cultures from various areas of a school.
- To determine which environments harbor and support bacterial growth.

WHAT YOU NEED

- 1 petri dish with agar (per group of four students)
- 2 cotton swab sticks
- masking tape
- marker
- index cards
- incubator or warm area to grow the bacteria

WHAT TO DO

- Ask students to name specific locations in the school where they would expect to find a lot of bacteria and where they would expect to find very few bacteria. For example, students might name the bathroom doorknob, benches in the locker room, a computer keyboard, or the office telephone. List these locations on a chalkboard and write each location on an index card.

- Divide students into pairs, and put two pairs on one team. Each team will share a petri dish containing agar (a gelatinous material prepared from algae). Tell students to turn the dish upside down and put a piece of tape down the middle of the dish to divide it in half. Use a marker to draw a line down the center of the tape. Students also should put a piece of tape on each side of this center line to serve as labels for their initials. Each pair of students will use one-half of the dish. They should write their initials on the tape on their half.

- Randomly assign a location to each pair of students by allowing the pair to draw a labeled index card. Have the students put their names on the chalkboard next to the location they selected. Students in each pair should add the date and their sample location to the label on the bottom of the petri dish.

- Demonstrate to students how they are to collect the samples. One student should rub the cotton swab over the surface being sampled, while the other student partially removes the lid of the petri dish. Each student should lightly rub the swab over the agar on his/her side of the dish. Then students should promptly close the lid and tape it to the dish.

- Give students fresh cotton swabs and send them to quickly collect their samples.
- Tell students not to leave the lid off of their dish or touch the agar with their fingers. Bacteria in the air or on students' hands could contaminate the sample. Similarly, students should be careful not to contaminate the cotton swabs before collecting their samples.
- Once students return from collecting their samples, have each one draw what his or her dish looks like and label the drawing with the date and sample location. Also, have students record the number of colonies they see. Fuzzy colonies are fungus, not bacteria.
- Move the petri dishes to the incubator/warm area. Have students regularly re-examine the dishes.

QUESTIONS TO ASK (Answers are in parentheses)

1) How many colonies of bacteria are growing in your petri dish? How does this compare with the bacteria in other petri dishes?
(Students' answers will vary.)

2) Considering where you collected your sample, did your dish have more or less bacteria than you expected? Why?
(Students' answers will vary.)

3) Think about all the locations whose samples had lots of bacteria. What are some common things about these locations that might make them good spots for bacteria to grow? Which locations did not have lots of bacteria? Why not?
(Students' answers will vary.)

4) How can you control how much bacteria with which you come in contact?
(Students' answers will vary.)

BRIEF EXPLANATION

Bacteria are microorganisms too small to be seen by the naked eye. Most bacteria are helpful to animals and humans. For example, there are many bacteria in the soil that break down dead plant and animal matter to help return nutrients to the soil. Millions of beneficial bacteria also live in the human digestive tract and help in digestive processes. However, the bacteria that are best known are those few that are harmful to humans and can cause disease, such as salmonella.

Bacteria exist almost everywhere, but they grow best in warm, dark environments. Students should know that a simple hygiene practice like washing their hands before eating can limit their encounters with harmful bacteria.

EXTENSION

- Leave a petri dish out in the classroom without a lid for an hour or two. Tell students that bacteria in the air are landing on the dish all the time. Add this dish to the students' samples.

Adapted with permission from *E.S. Balasic, www.middleschoolscience.com*, 2000.

THE BIG BANG

GROUP SIZE: 1-2
TIME: 10 minutes

PURPOSE

- To observe the formation of a gas when an acid and a base are mixed.
- To study how gases can exert pressure on their surroundings.

WHAT YOU NEED

- water
- 1 small zippered plastic bag
- paper towels
- 1 1/2 tablespoon baking soda
- 3/4 cup vinegar
- 1 bowl (large enough to hold the zippered bag)

WHAT TO DO

- Test the zippered bag for holes by filling it halfway with water and turning it upside down. If the bag does not leak, empty the bag and continue. If it leaks, try a new bag.
- Put 1 1/2 tablespoons of baking soda in the center of a paper towel sheet.
- Fold the sides of the paper towel over the baking soda. Make sure the baking soda still remains in the center. Then, fold the top and bottom portions of the paper towel over the baking soda. This will result in a small packet.
- Gently lay the packet on a flat surface with the folded portions of the paper towel facing the surface.
- Pour 3/4 cup of vinegar into the plastic bag.
- Carefully place the packet containing the baking soda inside the bag and zip the bag closed. Do not let the packet touch the vinegar immediately.
- Slowly release the packet into the vinegar.
- Gently shake the bag and put the bag into the bowl.
- Stand back.

QUESTIONS TO ASK (Answers are in parentheses)

1. What happened when the packet of baking soda and vinegar were mixed?
(The vinegar began to fizz and the bag began to expand.)
2. Why did the bag expand and pop?
(Responses will vary.)
3. Did the bag pop immediately or did it take some time?
(Responses will vary.)

BRIEF EXPLANATION

The reaction between vinegar (an acid) and baking soda (a base) represents one of the most important reactions in chemistry. The reaction is referred to as an acid-base reaction.

In this activity, vinegar is an acid called acetic acid and baking soda is a base called sodium bicarbonate. When vinegar and baking soda are mixed they produce a white salt and water. They also produce a gas called carbon dioxide.

Since the carbon dioxide was confined to the small area inside the bag, it exerted pressure on the sides of the bag. The pressure continued to increase until finally the bag popped.

EXTENSION

- Repeat the activity by making one of the following changes:
    - Add less baking soda.
    - Decrease the amount of vinegar to 1/2 cup and add 1/4 cup of water.
    - Use toilet paper or tissue paper instead of paper towels to contain the baking soda.
- Observe any changes in the reaction.

Adapted with permission from *Science Exploratorium*, 2000.

FIZZ ROCKET

GROUP SIZE: 1-2
TIME: 15 minutes

PURPOSE

- To design a paper rocket propelled by an effervescing (fizzing) antacid tablet and water to demonstrate Newton's Third Law of Motion.

WHAT YOU NEED

- effervescing (fizzing) antacid tablets (Alka-Seltzer)
- water
- 8 1/2" x 11" paper
- tape
- scissors
- paper towels
- markers, crayons, or other materials for decoration
- 35 mm film canister (Use Polaroid or Fuji film canisters for best results.)

WHAT TO DO

- Remove the lid from the canister (rocket).
- Fill 1/4 or less of the canister with water.
- Very quickly drop 1/2 of the antacid tablet into the canister and snap the lid on the canister.
- Stand the canister on a platform (lid down). A sidewalk, floor, or any flat surface can be used as a platform.
- Stand back and wait for the canister (rocket) to blast off. Be patient, it may take 15-30 seconds to launch.

QUESTIONS TO ASK

(Answers are in parentheses)

1) What happened when the tablet was added to the water?
(The water began to fizz.)

2) What happened to the film canister when the tablet was added?
(The lid flew off the film canister and the canister began to rise.)

3) How high did the rocket go?
(Responses will vary. The rocket can go at least 5 feet.)

BRIEF EXPLANATION

Sir Isaac Newton (1642-1727), a famous mathematician and scientist, developed explanations on how and why objects move. These explanations are known as Newton's Three Laws of Motion. This activity demonstrates one of the laws, Newton's Third Law: The Law of Action and Reaction. The Law of Action and Reaction states, "for every action there is an equal and opposite reaction."

During the activity, the rocket is launched using water and an antacid tablet as fuel. When the tablet is enclosed in the water-filled canister, the tablet and water begin to react to produce a gas. As the reaction continues, more gas is produced which eventually puts pressure against the film canister. The building gas pressure increases so much that eventually the lid, which is on the bottom since the canister is upside down, pops. The water and the gas rush down and out of the canister. The release of the water and gas pushes the rocket upwards.

Based upon the Law of Action and Reaction, the action is the gas leaving the canister and the opposite reaction is the rise of the rocket. The speed of the rocket is proportional to the speed of the gas being released; therefore, the faster the gas leaves the canister, the faster the rocket rises.

EXTENSION

- Use different amounts of water and/or tablets and see how it affects the height of the rocket. What is the best combination to produce the maximum height?
- Design and launch a rocket powered by two or more film canisters.

Adapted from public domain (http://spaceplace.jpl.nasa.gov/rocket.htm).

WINGLESS GLIDER

GROUP SIZE: 1 - 2
TIME: 60 minutes

PURPOSE

- To examine gravity and air resistance.
- To collect sample measurements and compute an average.

WHAT YOU NEED

- drinking straw (non-flexing)
- scotch tape
- index card
- scissors
- ruler
- makers or crayons
- 20' measuring tape

WHAT TO DO

- Cut the index card into three equal strips lengthwise. Each strip should be about one inch wide by five inches long. Have students decorate the strips with markers or crayons.

- Take one of the three strips and bend it into a loop. Tape the ends of the loop together. The circumference (perimeter) of the loop should be about the same as that of a ping-pong ball.

- Tape the remaining two strips together, end to end, to make one long strip that is one inch wide and about ten inches long. Then, bend this long strip into a big loop and tape the ends. The circumference of this loop will be approximately the same as that of a baseball.

- Place the straw on a flat surface and tape the middle of the straw to the surface. This holds the straw in place while the loops are being added.

- Take the small loop and slide it under one end of the straw. Push it onto the straw so that its outer edge aligns with the end of the straw. Put a piece of tape on the inside of the loop, and tape the loop to the straw.

- Take the larger loop and slide it under the other end of the straw. Again, make sure its outer edge aligns with the end of the straw. Use tape to secure this loop to the straw.

- Once both loops are in place, remove the tape that holds the straw to the desk. Now the glider is ready to fly. Let students know that the small loop is the front of the glider and the large loop is the rear. Find an open space and give the glider a toss.

- Have students collect sample measurements of the distances flown by their gliders. Then, find the average distance flown by all of the gliders.

QUESTIONS TO ASK (Answers are in parentheses)

1) In your records, what was the farthest distance a glider flew? What was the shortest distance a glider flew? On average, about how far did most gliders fly?
(Distances and averages will vary from class to class.)

2) Imagine we are going to have a contest to win a pizza. To win, you must guess how far my glider will go before I throw it. I will choose a glider at random after you have written your guess. Whoever comes closest to the correct distance will win. Based on the data we have collected about the gliders, what guess would you make? Why?
(Students' answers will vary.)

3) Today when we threw the gliders, what are some things that affected how far a glider would go? List as many things as you can.
(Students' answers will vary and could include the following: gravity, wind, slope of the land, glider construction/materials, arm strength/coordination, and air resistance.)

4) What is the main reason the glider falls to the ground? What is gravity?
(Gravity causes the glider to fall because it is a force that pulls everything -- even air -- toward the ground. When one lifts a book, its weight can be felt because gravity pulls it downward. All matter has a gravitational force that attracts other matter. Even a pencil has a tiny gravitational force that attracts other objects. However, only very, very large objects -- like a planet or moon have enough mass to create a gravitational force strong enough to be felt and measured.)

5) What is the main thing that keeps the glider temporarily up in the air?
(Air slows the glider's fall and keeps it up. Air resists all falling objects; the larger the surface area of the object, the greater the air resistance. For example, consider how a parachute slows the fall of a person being pulled to Earth by gravity. In the same way, the loops of a glider are like parachutes that the air acts against during the glider's fall.)

BRIEF EXPLANATION

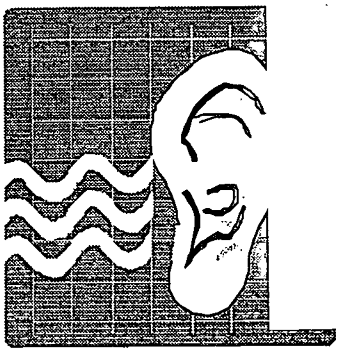
The average of a set of numbers is the value that is most typical of that set. For example, imagine that 20 gliders were each thrown once and the distances of their flights were measured. To find the average distance that the gliders flew, students would add the distances of all the trials together and then divide by the total number of trials, which is 20. If students understand the concept of an average and know the average distance the gliders flew, they can make an educated guess about how far the glider would fly in the pizza contest.

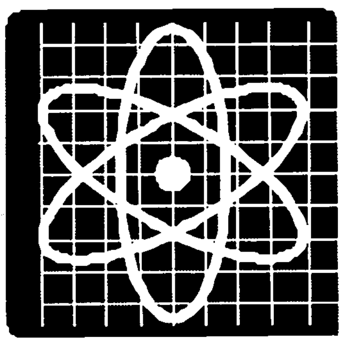
Aside from heavy winds, gravity is the strongest force pulling the glider to the ground. Alternatively, air acting on the wide surfaces of the loops provides the greatest resistance (air resistance) to the downward force of gravity.

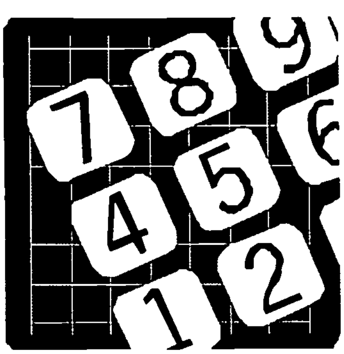
EXTENSION

- To introduce students to the scientific method, propose the *question*, "What changes do you think we could make to a glider to make it fly farther?" Treat the students' responses as *hypotheses*. Based on the hypotheses, the students' *procedure* would be to design and test a number of new prototype gliders. Have the students collect sample distances flown by the gliders and report the *results*. In *conclusion*, state whether the hypotheses tested were true. (The basic steps of the scientific method are italicized and listed sequentially.)

Adapted with permission from *Science Exploratorium*, 2000.







and Science Activities for Grades 6 - 8

Quality Education for Minorities (QEM) Network

NIMBLE CALCULATOR

GROUP SIZE: 2
TIME: 15-30 minutes

PURPOSE

- To develop strategies, use patterns as clues, practice addition and subtraction, and learn calculator operation skills.

WHAT YOU NEED

- basic calculator

WHAT TO DO

- Group students in pairs and give each pair a calculator. Give each pair a copy of the Nimble Calculator worksheet (included below) which explains a series of six games, each one more challenging than the previous one.

- To play each game, follow the instructions provided in the worksheet. Choose who will go first, then begin. After each match, let the loser choose who will play first in the next match. Play a few matches in each game before moving on to the next one.

- Have players watch for the point in each match where it is clear who will win. Have them look for patterns or strategies that decide who will win. Ask them to discuss their observations with their respective partners.

QUESTIONS TO ASK

(Answers are in parentheses)

1) Who won the most games? Which games were most interesting or challenging? Why?
(Students' responses will vary.)

2) What patterns did you discover, if any? Based on the patterns, what were your strategies for winning?
(All of these games utilize one basic mathematical "strategy," as described in the explanation. However, each game has a different start point, end point, and range of numbers that students must identify in order to win consistently.)

3) Did you discover the twist in *Century*?
(Unlike the other games in which taking the first turn is an advantage, in *Century* it is advantageous to go second. This is because the end point in *Century* is an even number.)

BRIEF EXPLANATION

Students can discover how to win each of the games by counting backwards from a game's end point. For example, Kay and Gene are playing *7Up*, where the goal is to reach 7 by adding 1's or 2's. Moving backwards from 7, Kay knows that if she makes the total either 5 or 6 on her turn, then Gene can win by adding 1 or 2. Reciprocally, if Gene makes the total either 5 or 6, Kay can win on her next turn. So, Kay deduces that she can win if she ensures that Gene on his turn makes a total of 5 or 6. To "force" Gene to do that, Kay realizes she should aim at getting a sum of 4; then, she would be guaranteed a win. But, if Gene gets to 4 first, then he's sure to win.

So, how does Kay get to 4 before Gene does? Kay knows that if she makes the total 2 or 3, then Gene can get to 4 by adding 1 or 2. Then, he would eventually win. Reciprocally, if Gene makes the total 2 or 3, Kay can get to 4 and win the game. So, if Kay does not want to make the total 2 or 3, then the only option left is 1. If Kay makes it to 1 first, then she is guaranteed to win!

If Kay understands the strategy of the game and can get to 1 first, then she knows she will win, no matter what Gene does.

How can Kay get to 1 first? The only guaranteed way is to have the first turn. Students may find it remarkable to discover that the winner of the game can be determined from the very first move!

EXTENSION

- Have students create their own calculator games by choosing a start point, end point, and range of numbers that can be added on each turn. Ask them to explain the best strategies for winning their games.
- Older students can use this activity as a springboard for discussing mathematical "game theory," the study of human behavior/choices using mathematical models.

Adapted with permission from *Family Math*, Lawrence Hall of Science, 1986.

Worksheet: Nimble Calculator

7Up

Clear the calculator so it reads 0. Taking turns, each player adds either 1 or 2 to the calculator sum. The winner is the first person to reach 7 exactly.

Start: 0 Add: 1 or 2 Target: 7

11 Down

Clear the calculator and enter 11. Subtract 1 or 2 on each turn. The winner is the first person to reach 0.

Start: 11 Subtract: 1 or 2 Target: 0

Now You're 21

Clear the calculator so it reads 0. Add 1,2,3, or 4 on each turn. The first person to get 21 exactly is the winner.

Start: 0 Add: 1,2,3, or 4 Target: 21

Travel Down 101

Enter 101 on the calculator. Each person in turn subtracts 1,2,3,4,5,6,7,8, or 9 from the number in the display. The winner is the first person to make the display read 0.

Start: 101 Subtract: 1-9 Target: 0

Century

Start at 0 and add 1-9 on each turn. The first person to reach 100 exactly is the winner.

Start: 0 Add: 1-9 Target: 100

2001

Enter 2001 in the calculator. Subtract 1-99 on each turn. The first person to reach 0 exactly wins.

Start: 2001 Subtract: 1-99 Target: 0

THREE BEAN SALAD

GROUP SIZE: 1 - 2
TIME: 20 minutes

PURPOSE

- To practice working with ratios and using basic algebra to discover the exact ingredients of the eight bean recipes.

WHAT YOU NEED

- 3 types of dry beans (about 15 red beans, 15 lima beans, and 15 black-eyed peas)
- paper plates or bowls to hold the beans

WHAT TO DO

- Distribute the three types of beans to each student so that each has a set of red beans, lima beans and black-eyed peas. Give each student an extra plate or bowl on which to make a salad.

- Distribute the recipes' worksheet (given below) to each student. Tell students that all three types of beans go into each salad. Using the beans provided, students should follow the clues in each recipe to discover how many red beans, lima beans, and black-eyed peas are needed to complete each salad.

QUESTIONS TO ASK (Answers are in parentheses)

1) How did you determine the number of beans that are needed in each recipe?
(Students' answers will vary.)

2) Which recipes were easy to solve? Which ones were difficult? Why?
(Depending upon the students' exposure to ratios, proportions and basic algebra, they may treat the recipes as mathematical word problems, working out their solutions on paper. Other students might use a trial and error method, manipulating the beans to discover the correct ingredients. In the former case, recipes with the most straightforward language might be the easiest to complete. In the latter case, recipes with the fewest total beans might be easiest because their ingredients could be discovered in fewer trials.)

3) What might these recipes look like if they were algebra problems?
(The answer varies for each recipe. See the following explanation and example.)

BRIEF EXPLANATION

Explain or review the term ratio.

> *A **ratio** is a measure of the relative size of two quantities or numbers and is expressed as the quotient of one divided by the other.* For example, if we have 3 times as many red beans as lima beans, our ratio is 3 (red beans) to 1 (lima bean), or 3/1. Or, if we have only one black-eyed pea for every 2 red beans, then the ratio is 1 (black-eyed pea) to 2 (red beans), or 1/2.

Though students may not realize it, they will use algebraic skills to solve these problems. Show them how each recipe has the same basic mathematical formula:

Red beans + Lima beans + Black-eyed peas = Total beans

This formula can be abbreviated with letters to symbolize the amount of Red beans (R), Lima beans (L), Black-eyed peas (B), and Total beans (T).

$$R + L + B = T$$

For Recipe 1, two clues say that the recipe has 2 Limas and 10 beans total, so enter these numbers into the formula, because L=2 and T=10.

$$R + 2 + B = 10$$

The third clue is a bit tricky. "Twice as many Reds as Limas" can be written mathematically in a few ways, but both ways really say the same thing: the ratio of Red beans to Lima beans is 2 to 1, or 2/1. Look at these options and ask students which one they prefer.

$$R = 2L \quad \text{or} \quad R/2 = L$$

or example, use R = 2L to figure out how many Red beans are in the salad. If it is known that there are 2 Limas in the salad, then:

$$R = 2(2) \quad \text{which is} \quad R = 4$$

So now there are 4 Reds, 2 Limas and 10 beans all together. All that remains is to find the number of Black-eyed peas in the salad. Ask the students if they can show you the rest.

$$4 + 2 + B = 10$$

$$6 + B = 10 \quad \text{which is} \quad B = 10 - 6$$

$$B = 4$$

EXTENSION

- Create a new salad and then write clues (instructions) on how to make it. Share the clues with a friend to see if he or she can discover the correct ingredients.

Adapted with permission from *Family Math*, Lawrence Hall of Science, 1986.

Worksheet: Three Bean Salad Recipes

1

This salad contains:
- 2 Lima beans
- Twice as many Red beans as Lima beans
- 10 beans in all

2

This salad contains:
- 4 Red beans
- 1/2 as many Black-eyed peas as Red beans
- 10 beans in all

3

This salad contains:
- Lima beans that make up 1/2 of the salad
- Exactly 2 Red beans
- Lima beans that double the number of Red beans

4

This salad contains:
- The same number of Red beans as Lima beans
- 3 more Black-eyes than Red beans
- A total of 18 beans

5

This salad contains:
- Exactly 12 beans
- Red beans as 1/2 of the beans
- Lima beans that make up 1/4 of the salad

6

This salad contains:
- At least 12 beans
- One more Lima beans than Red beans
- One more Red beans than Black-eyes

7

This salad contains:
- 3 times as many Red beans as Black-eyes
- One more Lima beans than Red beans
- 8 beans in all

8

This salad contains:
- An equal number of Red beans and Black-eyes
- 5 more Lima beans than Red beans and Black-eyes
- No more than 20 beans

TOOTHPICK GEOMETRY

GROUP SIZE: 1-2
TIME: 30 minutes

PURPOSE

- To develop creative problem solving skills and spatial thinking abilities using a hands-on mathematics manipulative.

WHAT YOU NEED

- toothpicks (about 25)
- a coin
- puzzle sheet
- colored paper (1 sheet)

WHAT TO DO

Each toothpick puzzle begins with a design made of toothpicks. Using the colored paper as a workspace, create the beginning picture with your toothpicks.

Each puzzle has a challenge for you to solve. To solve the challenge, you will have to move or remove some of the toothpicks in your design to create something new. Follow the instructions closely. If some puzzles seem odd or impossible to solve, they may require you to think about or "see" the puzzle in new ways. Some of the puzzles have more than one correct answer.

QUESTIONS TO ASK (Answers are in parentheses)

1. Which puzzles did you find most interesting? Most challenging? What made some of the puzzles easy for you, and others more difficult?
(Responses will vary.)

2. Were there any puzzles for which you found more than one answer? Which ones?
(Responses will vary.)

3. What was "tricky" about some of the puzzles? In other words, how did you have to change your thinking or perspective to solve those puzzles?
(Responses will vary.)

BRIEF EXPLANATION

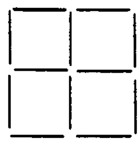
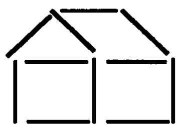
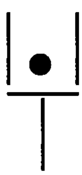
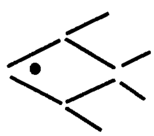
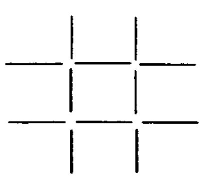
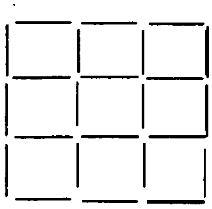
Often when we are presented with a problem in life, we first try to solve it using methods that we have already used before. Sometimes our problem solving methods become "habitual" in the sense that we want to use the same method to solve lots of different problems, even though it's not always the *best* method for every problem. Students can develop similar kinds of bad habits in school if they aren't challenged to be creative and look at a mathematics problem, science project, or English poem in a new way. These toothpick puzzles train the brain to look for alternative ways of thinking that might help us find new ways of doing things. They also develop our "right-brain" thinking skills by teaching us new ways to visualize possible outcomes.

EXTENSION

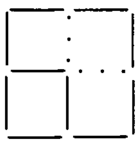
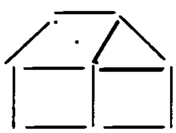
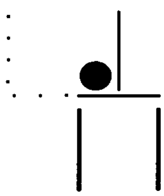
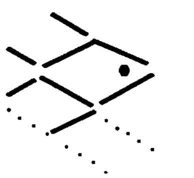
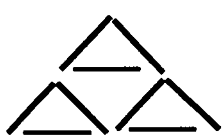
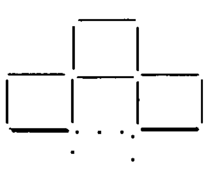
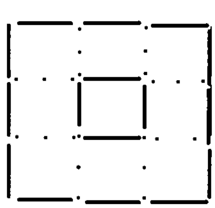
- Change the rules or the goal for one of the puzzles. Try it on a friend.
- Create your own puzzles using toothpicks, coins or other objects.

Source: *Gigantic Book of Puzzles*, 1999

Toothpick Geometry Puzzle Worksheet

Starting design:	Instructions:
	**Square Deal** The toothpicks in this diagram have been arranged to form squares. Can you remove two of the toothpicks so that only two squares remain?
	**Architect** Build a house using 11 toothpicks as shown in the diagram. See if you can make the house face the opposite direction by moving only one toothpick.
	**In and Out** The four toothpicks in this diagram represent a wine glass with a coin inside. See if you can move two toothpicks so that the coin is *outside* the glass.
	**Aquarium** Make a fish using eight toothpicks and a coin as shown in the diagram. Move only three toothpicks and the coin so that the fish is swimming to the right. You may change the location of the eye.
	**Pyramids** Use nine toothpicks to make three congruent (same-sized) triangles. See if you can move three of the toothpicks to create four congruent triangles.
	**Criss-cross** Arrange 12 toothpicks as shown in the diagram. Can you move only three toothpicks and end up with exactly three congruent squares?
	**Checkerboard** Use 24 toothpicks to create the checkerboard in the diagram. Can you remove exactly eight toothpicks so that two squares remain?

Toothpick Geometry Puzzle Solution Worksheet

	**Square Deal** The toothpicks in this diagram have been arranged to form squares. Can you remove two of the toothpicks so that only two squares remain? (Remove the two toothpicks as shown.)
	**Architect** Build a house using 11 toothpicks as shown in the diagram. See if you can make the house face the opposite direction by moving only one toothpick. (Move one toothpick as shown.)
	**In and Out** See if you can move two toothpicks so that the coin is *outside* the glass. (Slide the horizontal toothpick midway under the vertical toothpick on the right. Move the vertical toothpick on the left to the bottom right side.)
	**Aquarium** Make a fish using eight toothpicks and a coin as shown in the diagram. Move only three toothpicks and the coin so that the fish is swimming to the right. (Move the three toothpicks as shown from the original design to get the new design.)
	**Pyramids** Use nine toothpicks to make three congruent (same-sized) triangles. See if you can move three of the toothpicks to create four congruent triangles. (Move the third triangle on the right to the top of and between the first two triangles.)
	**Criss-cross** Arrange 12 toothpicks as shown in the diagram. Can you move only three toothpicks and end up with exactly three congruent squares? (Move the three toothpicks shown to the left, right, and top sides to form the three congruent squares.)
	**Checkerboard** Use 24 toothpicks to create the checkerboard in the diagram. Can you remove exactly eight toothpicks so that two squares remain? (Move the eight toothpicks that touch the middle square.)

DNA - NOW YOU SEE IT!

GROUP SIZE: 1-2
TIME: 30 minutes

PURPOSE

- To learn the technique of DNA extraction by observing the DNA of a banana.

WHAT YOU NEED

- banana
- blender
- liquid dishwashing detergent
- meat tenderizer
- strainer
- cup
- small glass jar
- rubbing (isopropyl) alcohol
- salt
- toothpick

WHAT TO DO

- Cut the banana into pieces.
- Put the banana pieces into the blender. Pour enough warm water into the blender to barely cover the pieces in the blender. Add a teaspoon of salt.
- Blend the mixture for 5-10 seconds. The mixture should be mushy, but not runny.
- Using the strainer to strain the mush into a cup. Discard the solid pieces that remain in the strainer and keep the liquid in the cup. The liquid in the cup will be referred to as the soup.
- Add 2 teaspoons of liquid detergent to the soup and gently stir. Try to avoid creating bubbles while stirring.
- Add 1 teaspoon of meat tenderizer to the soup and continue stirring for 5 minutes.
- Pour half of the soup into a glass jar.
- Carefully pour an equal amount of rubbing alcohol down the side of the jar.
- Let the mixture sit for 5 minutes. Wait for two layers to form.
- With a toothpick, remove the white, stringy stuff. That is DNA!

QUESTIONS TO ASK (Answers are in parentheses)

1) What happened when you poured the mush through the strainer? How much liquid remained after straining? Was it more or less than you expected?
(Only a small amount, approximately one-fourth, of the mush will pass through the strainer. The remaining portion, the large banana pieces and chunks, will remain in the strainer. Answers will vary on whether the amount was more or less than expected.)

2) What happened to the soup after the detergent was added?
(The soup will begin to look cloudy.)

3) What happened to the soup after the meat tenderizer was added?
(White, stringy stuff will begin to appear in the soup.)

4) What happened to the soup when the alcohol was added?
(Two layers began to form. The bottom layer contained the soup and the top layer contained the alcohol and white stringy stuff.)

5) What is the white stringy stuff?
(The white, stringy stuff is DNA.)

BRIEF EXPLANATION

The white stringy stuff appearing at the end of the experiment is DNA. DNA stands for deoxyribonucleic acid. DNA is found in every living (and formerly living) thing. It is often referred to as the blueprint of life because it determines what a living organism will become and how the organism will function.

Normally, DNA cannot be seen by the naked eye because it exists within cells and is very compact. DNA can be separated from the cell and unraveled using a method called DNA extraction which makes it visible.

DNA can be extracted in a variety of ways. However, all DNA extraction techniques require at least three key ingredients added in this order: Detergent, eNzyme, Alcohol. The detergent breaks the cell apart to release the DNA and other cell parts. The enzyme causes the DNA to unravel and uncoil by cutting proteins that keep the DNA in a tight bundle. (DNA is very long, and if it were not coiled and packaged tightly, cells containing it would have to be very large. For instance, if the DNA of humans were unraveled and laid end to end, it would stretch the distance between the Earth and the moon approximately 6,000 times.) The alcohol separates the DNA from the other cell parts.

EXTENSION

- Try extracting DNA from one of the following sources: spinach, onions, broccoli, or baking yeast. Compare the source's DNA with the banana's DNA. Do the DNAs differ?

- Experiment with different types of detergents or meat tenderizers. Do certain detergents or meat tenderizers work better than others?

Source: Natural History of Genes, University of Utah.

LUBE LAB

GROUP SIZE: 1 - 2
TIME: 45 minutes

PURPOSE

- To test the quality of different chemical substances as lubricants.
- To examine how lubricants work.

WHAT YOU NEED

- 4 envelopes unflavored gelatin
- square baking pan
- mixing bowl
- liquid dish detergent
- vegetable oil
- 2 bowls
- watch with a second hand
- table knife
- 8-ounce cup
- sheet of paper and a pencil

WHAT TO DO

- In a mixing bowl, dissolve 4 envelopes of gelatin in 2 cups of hot tap water.

- Coat the inside of the baking pan with vegetable oil. Pour the gelatin mixture into the pan and put it in the refrigerator until firm (about 3 to 4 hours).

- Use the knife to cut the gelatin into cubes about 1 cubic inch. This should make about 64 cubes.

- Have each student create a table of two columns and four rows. Label the first column "Type of lubricant," and the second column "Number of cubes moved." Under the heading for lubricants, in the first row write "No lubricant," in the second row, write "Dishwashing detergent," in the third, "Water," and in the fourth, "Vegetable oil."

- Place 15 cubes into a bowl. Place an empty bowl about 1 foot away from this bowl.

- One student's task will be to quickly but gently pick up -- with thumb and index finger -- individual cubes and move them to the empty bowl. Another student will time this student with a watch to see how many cubes the student moves in 15 seconds. Have students switch roles so that each has the opportunity to move the cubes and use the watch. Students should record these data in their tables.

- Put all the cubes back in the bowl from which they were taken. Pour 1/4 cup dishwashing detergent over the cubes. Gently mix the detergent and the cubes so that the cubes are well-coated.

- Use the same method as before to have students transfer as many cubes as possible in 15 seconds. Again record the data.

- Throw away the cubes and detergent, then wash and dry both bowls. Put about 15 new cubes into one bowl and pour 1/4 cup water over the cubes, making sure the cubes are thoroughly coated. Have students see how many cubes they can transfer in 15 seconds. Record the data.

- Throw away the cubes and water. Put about 15 new cubes into one bowl. Pour 1/4 cup of vegetable oil over the cubes. Make sure they are well coated. See how many cubes students can transfer in 15 seconds. Record the data.

QUESTIONS TO ASK (Answers are in parentheses)

1) In which trial were you able to transfer the most cubes? In which trial did you transfer the least?
(Students' answers may vary.)

2) Based on your trials, which substance was the best lubricant (the most slippery)? Which was the worst?
(Students' answers may vary.)

3) What are some other substances that you know are lubricants? When chemists look for new lubricants, what qualities do you think those lubricants should have?
(Students' lists of other lubricants will vary and may include the following: motor oil, grease, "WD-40", vaseline, or the synovial fluid in body joints that allows bones to slide past each other. As chemists work to discover or invent new lubricants, especially for engines, they look for substances that have a tolerance for high temperature, maintain their durability over time, and, naturally, further reduce the level of friction between moving parts.)

BRIEF EXPLANATION

In engines, machines, and the human body lubricants help to protect parts that rub against each other by reducing the friction between them. Lubricants help these parts to move together smoothly and easily. There are many types of lubricants, natural and artificial, that serve a wide variety of purposes. Most lubricants are liquids, and many are made from crude oil. However, some solids (for example, graphite) also can be used as lubricants.

Cars, trucks, airplanes and the human body all have moving parts that depend on lubricants to function. Without lubricants, these moving parts would soon heat up, wear down, and eventually stop working.

EXTENSION

- Try using other common, safe liquids to test them as lubricants. Have students compare their findings against the data they collected for water, a detergent, and vegetable oil.

Adapted with permission from *Department of Education, <www.ed.gov/pubs/parents/Science/Home.htm>*, 2000.

BUILDING A BUILDING

GROUP SIZE: 4-16
TIME: 90 minutes

PURPOSE

- To apply students' understanding of physics to the design and construction of a small support structure.
- To practice bookkeeping and resource management skills.

WHAT YOU NEED

- thick uncooked spaghetti
- marshmallows
- glue or rubber cement
- play money
- watch with a second hand
- ruler
- piece of posterboard (6 inches by 6 inches)
- paper
- weight (i.e. paperback book)
- Expenses Worksheet

WHAT TO DO

- Divide the students into teams. Teams can have as few as 2 members or as many as 4.

- Give each team a copy of the Expenses Worksheet and $4,000 (play money) that team members will use to purchase materials.

- Explain the purpose and procedure of the activity as written below in italics. Show the students a "beam," "joint," and the "cement" while describing the activity. Put a copy of the building codes on an overhead transparency or on piece of poster paper where everyone can read them.

The purpose of this project is to build a structure that withstands the weight of a paperback book at least three inches above a base of posterboard for 60 seconds. This project also involves keeping track of the money that is spent for each team to build its structure.

The materials for construction of the building are "beams" (noodles), "joints" (marshmallows), and "cement" (glue). Each beam costs $100, each joint costs $50 and cement is free. Each team will have $4,000 (play money) to purchase its materials. Each team should choose an "accountant" to manage the money and keep a record of expenses. (See the Expenses Worksheet that shows students how to record expenses.)

Before construction begins, each member of the team should sketch a design for the structure. As you create your design, keep in mind that you have a limited amount of money and materials to build your structure. You will have 10 minutes to design your structure on paper. Then, within your team, you will decide on one design that your team will build. After making this decision, your team can purchase its materials from the "Supply Store."

Teams will have 40 minutes to complete their structures. Teams can choose any combination of materials to use, and materials can be purchased anytime during the construction process. However, all construction teams must follow these important building codes (rules):

Building Codes:
- *Teams can only use glue to attach the base beams or joints to the posterboard to prevent these items from sliding off the board.*
- *Teams may break the beams.*
- *The beams must be joined using joints, not cement.*
- *Teams may not touch another group's table or project.*
- *If teams have extra materials left over, they cannot sell these back to the Supply Store. However, they can sell the materials to another team or make a trade.*
- *Teams should try to keep as much money as possible until the end.*
- *Team members must make decisions together and divide responsibilities.*

The winning team is the one whose members follow directions, cooperate, have the most money left over and whose structure succeeds in supporting the weight of the paperback book for 60 seconds.

- After students complete their structures, ask them to report on how much money their teams have remaining. Post the amounts in front of the whole group.

- Test the structures with the designated weight and a watch. Allow teams to place the weight on their structures themselves. Be sure each structure is at least three inches tall.

- Use the following three criteria to determine which team wins. The team that meets the most criteria is the winner. If there is a tie between two or more teams, then the tie is broken by determining which team had the most money remaining at the end of construction.

  Criteria to determine the winner:
  1) Did the team members cooperate when choosing a design, constructing the building, and making other decisions?
  2) Did the team members follow all of the building codes?
  3) Did the team's structure support the weight for 60 seconds?
     Tie-breaker: How much money did the team have left over at the end of construction?

QUESTIONS TO ASK (Answers are in parentheses)

1) Whose building was the strongest? Which team cooperated best? Which team had the most money left over?
(Students' answers will vary.)

2) What made some buildings stronger than others? Which designs worked best?
(Students' answers will vary. Generally speaking, buildings that utilize arches or zig-zagged beams are strongest. Buildings with vertical beam structures will twist and fall under weight.)

BRIEF EXPLANATION

This activity encourages students to be creative and practice teamwork while trying to accomplish a task. Students also use their natural understanding of the physical world to make choices about which designs they think could work and which ones will fail. There are no correct or incorrect designs for the buildings, and there are no right or wrong processes for completing the task. Instead, this activity encourages students to use whatever skills they have. For example, students use good communication skills, creativity, leadership ability, spatial thinking skills, mathematics skills, and cooperation to help their team complete the task. Additionally, each student also may improve in one or more of these skill areas through informal interaction with his or her peers.

EXTENSION

- Try other materials for the construction process or try to build other structures, like bridges.
- Have a contest to see who can build the *tallest* building with just $4,000.

Adapted with permission from public domain, *barbara@cosmicwindstudios.com*, 2000.

Building a Building Expenses Worksheet

Team: ______________________________ **Date:** __________________

In your expenses worksheet, record the following: the item you purchase, the cost per item, the quantity of these items you buy, and the total cost. Keep a running record of how much money you have all together, called your balance. At the beginning of the activity, your balance is $4,000. This number has been entered in the worksheet for you. Also, be sure to keep track of items that you purchase from other teams or items you sell to other teams. The balance in your worksheet should always match the amount of money your team is holding.

Item	Cost per Item	Quantity	Total Cost	Balance
				$4,000
1. Beam	$100	7	$700	-$700
				$3,300
2. Joint	$50	5	$250	-$250
				$3,050

Item	Cost per Item	Quantity	Total Cost	Balance
				$4,000
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

Total amount of money remaining after construction: ____________

Building a Building Play Money

This page contains a total of $1,000 in play money. Make copies and cut out four sheets to total $4,000 in play money.

$10	*$20*
$20	*$50*
$50	*$50*
$100	*$100*
$100	*$500*

MINI AIR-CANNON

GROUP SIZE: 1 - 2
TIME: 20 minutes

PURPOSE

- To explore how air moves in waves and how the flow of air can be condensed using a "funnel."
- To examine how changes in volume cause air to flow in or out of a container.

WHAT YOU NEED

- 20 oz. plastic bottle
- rubber band
- matches
- piece of plastic wrap (about the size of a paper towel)
- scissors
- candle

WHAT TO DO

- Cut off the bottom of the plastic bottle using the scissors. Make your cut about 1-2 inches from the bottom of the bottle. Save the bottom of the bottle for later use.

- Fold the plastic wrap into a square that is 2-layers thick and large enough to cover the new hole in your bottle. The square should cover the entire hole *and* wrap over onto the sides of the bottle. Cover the hole with the plastic wrap and secure the wrap with a rubber band. If there is a cap on the bottle, remove it.

- Hold the bottle in one hand so that the mouth is pointing away from your body and the end with the plastic wrap is facing your body. Use your other hand to flick the plastic wrap with your index finger. Test the bottle (cannon) to be sure that a spurt of air is "shooting" from the mouth when the plastic wrap is flicked. Try testing the cannon by aiming it at a piece of paper or another light object.

- Find the bottom that was cut from the bottle and set it on a flat surface. Put the candle in the bottom to catch melting wax. Carefully light the candle. Move about 3-4 feet from the candle, and try to blow it out using your mini air-cannon. See how far the cannon can "shoot" the air to blow out the candle.

QUESTIONS TO ASK (Answers are in parentheses)

1) How far can you "shoot" the cannon? Who could shoot the farthest?
(Answers will vary.)

2) How does the air-cannon work? Is it easier to blow out a candle with your breath or with the cannon? Why?
(When you use your lips and mouth to blow air, you create a steady movement of air from your mouth out into the room. The force of this moving air is strongest and most focused near your lips, but then the wave of air quickly spreads out and looses its force. The air-cannon also causes a movement of air, but its wave of air is much smaller in shape because of the funnel shape of the bottle. This concentrated wave of air is also pushed from the bottle with great speed, allowing it to remain more forceful over a distance and blow out a single candle several feet away.)

3) Which would be faster at blowing out candles on a birthday cake: your mouth or the air-cannon?
(Your mouth would probably be faster at blowing out several candles at once because the air from your lips spreads out in a big and steady wave to hit more candles more quickly.)

BRIEF EXPLANATION

Even when a bottle looks empty, it's really full... of air, that is! There is always some volume of air inside the bottle. (For example, in a 20 ounce bottle, 20 ounces of air fill the bottle.) Air fills all of the space inside the bottle, just as water would if the bottle was full of water. When the plastic wrap is flicked, the space inside the bottle suddenly gets smaller. When the space inside the bottle suddenly shrinks, some of the air is forced quickly from the bottle. The funnel-shaped bottle focuses that rushing air into a small but powerful wave that shoots out of the bottle and into the room. Immediately after the flick of the finger, the wrap returns to its regular position and new air enters the bottle to fill the space.

The human lungs work in a similar way. A muscle in the chest -the diaphragm- continuously causes the space in the lungs to grow and shrink and grow and shrink. When the space inside of the lungs shrinks, air is pushed out of the lungs like the air pushed out of the bottle. This happens when the diaphragm muscle relaxes. Next, the diaphragm contracts for a moment, which causes it to stretch the lungs. This stretching causes the space in the lungs to grow. Since there is now more room inside the lungs, new air rushes in from outside to fill up the extra space, that is, until the diaphragm relaxes again and the whole process starts over!

EXTENSION

- Make an air-cannon from a 2-liter soda bottle. Does it work as well as the small one? Why or why not?

Adapted with permission from *Bill Nye Outreach*, 2000.

Listed below are website and printed references that include "hands-on" mathematics and science activities and other helpful information for assisting students at various grade levels.

Website References

Organization/Activity	Web Address (http://)	Grade Level
AIMS Education Foundation	www.aimsedu.org	K-9
Amazing Space	amazing-space.stsci.edu	K-12
A Tour of Fractions	forum.swarthmore.edu/ paths/ fractions/index.html	K-12
Bizarre Stuff You Can Make in Your Kitchen	freeweb.pdq.net/ headstrong/ default.htm	K-12
Busy Teacher's Web Site	www.ceismc.gatech.edu/busyt	K-12
Cosmic Quest	www.childrensmuseum.org/ cosmicquest	4-12
Education 4 Kids	www.edu4kids.com	K-12
Enchanted Learning	www.enchantedlearning. com	1-8
Exploring Planets in the Classroom	www.soest.hawaii.edu/ SPACEGRANT/class_acts/	K-12
Hands-on Science Outreach, Inc.	www.hands-on-science.org	Pre K-6
Hands-on Technology (HOT)	www.galaxy.net/	K-8
Math Lessons that are Fun! Fun! Fun!	math.rice.edu/~lanius/ lessons/	K-12
Microgravity Science News and Research	www.microgravity.com	7-12
Microscopes, Cells, DNA, and You	chroma.mbt.washington. edu/outreach	4-12
Nebraska Earth Science Education Network (NESEN)	nerds.unl.edu	K-12
Newton's Apple	www.tpt.org/newtons	6-9

Website References (Continued)

Optimizing National Education	www.opnated.org/main. htm	K-6
Practical Uses of Mathematics and Science (PUMAS)	pumas.jpl.nasa.gov	K-12
Science on the Web	www.sec.noaa.gov	6-12
SEP Program	www.sep.org	K-12
Space Food and Nutrition	spacelink.nasa.gov/ products/ space.Food.and. Nutrition	K-8
The Exploratorium	www.exploratorium.com	K-12
The Science House	www.science-house.org	K-12
The Science of Light	www.learner.org/ teacherslab/ science/light	5-8
Surfing the Net with Kids	www.surfnetkids.com	K-12
Teachers Helping Teachers	www.pacific.net.net/ ~mandel/ Math.html	K-12
What an Idea! Classroom Activities	www.startribune.com /education/ subjects.html	K-12

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Printed References Continued

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